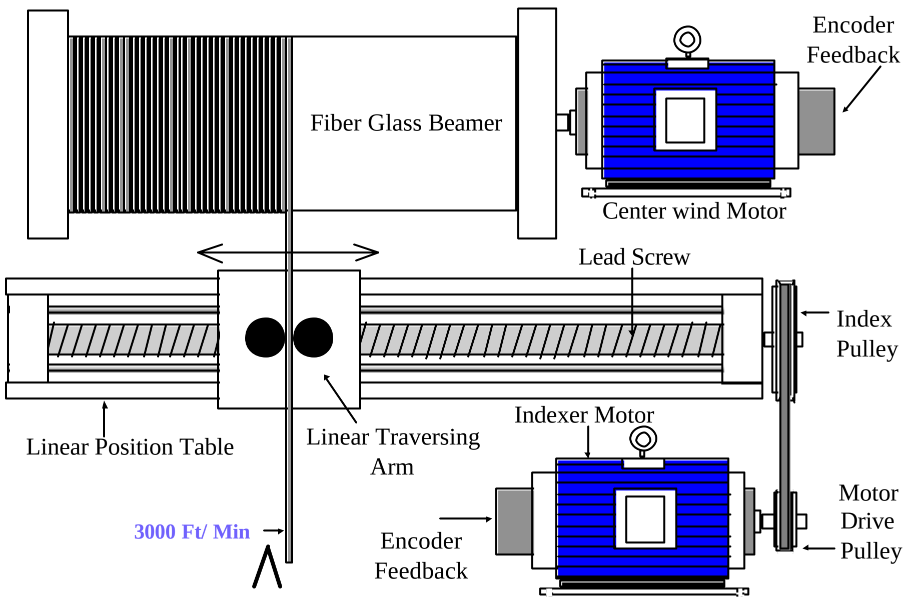
This form is used to help size common indexing applications. The form contains: Indexing overview, sizing example, and customer application data.



Indexing is a method of providing position and velocity control of a machine section or workpiece. Traditionally, Indexer control had been accomplished using stepper and servo controls. With the improvements of Flux Vector AC drives, which regulates the magnetic flux and torque generating current of induction motor, position and velocity control can be accomplished using the less costly Flux Vector drive.

The Servo or Vector drive controls the indexing motion by controlling the motor to move a predefined distance and velocity. An optical encoder or resolver is used to close the position and velocity loop during a move profile. The processor move command will be broken down into a specific number of pulses. During the move command, the encoder pulses provide feedback. By using **Custom Application Software**, the AC vector drive has the ability to count the number of pulses.

The predefined profiles are stored in the software [1], and the following parameters can be programmed.

[1] For GPD 515 using Custom Software, The version G5 + source code is required.

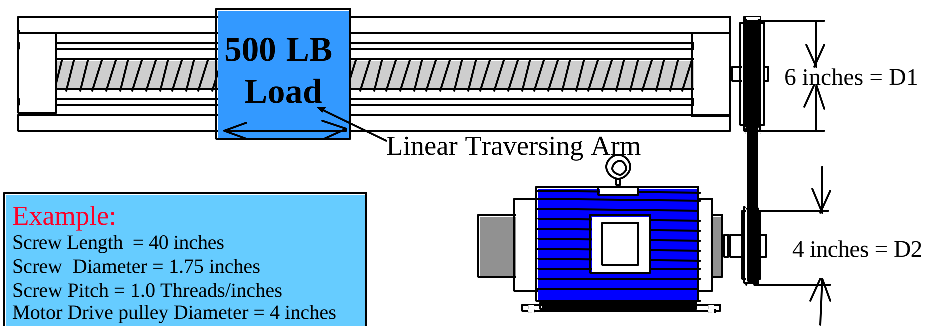
Parameters	Communication Control
Speed1, Home speed	Modbus
Preset Speed 1,2,3	Modbus-Plus
Acceleration	RS232-RS485
Deceleration	Profibus
Distance	Interbus
Dwell	
Home sequence	

Motion System Performance Comparison

Type	V/f Control	Vector Control	AC Servo
HP Range	0.5-1500 HP	0.5-1500HP	1-100 HP
Speed Range control	40:1	1000:1	200,000:1
Speed control accuracy	± 2%	± .01%	± .01%
Frequency control	1- 400 Hz	1- 400 Hz	1- 400 Hz
Torque Range		.01-150%	.01-200%
Torque Control	No	Yes	Yes
Velocity control	No	Yes	Yes
Positioning	No	Yes	Yes
Repeatability	Not Possible		± 1 arcmin
Motor Inertia:Load Intertia	N/A		10:1-200:1

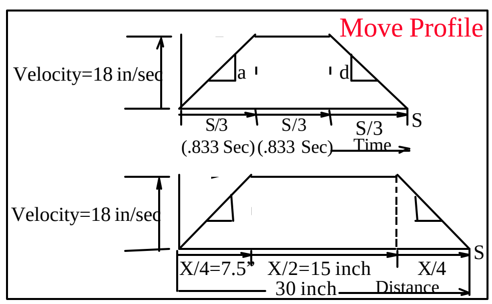
The application below requires calculations that are found on the next page. There are many different sizing programs in the market, but without having the basic understanding of the calculations, a critical profile or mechanical question could be missed.

The calculations require a few assumptions. The velocity & distance profiles are broken up into 3 sections. If you make the assumption that distance is x/4 (x is distance) for acceleration & deceleration, and x/2 for constant velocity, the Time profiles can be broken into s/3 sections (s is time). The profiles are given in the Move Profile below.



Example:
Screw Length = 40 inches
Screw Diameter = 1.75 inches
Screw Pitch = 1.0 Threads/inches
Motor Drive pulley Diameter = 4 inches
Index table pulley Diameter = 6 inches
W1 = Weight Load pulley=4 lb
W2 =Weight Motor Pulley = 9lb
Motion requirement = 30 Inches
Speed requirement = 2.5 seconds;
Distance X/4= a=-d & Distance X/2 Run

a = -d = Acceleration = ___________ in/sec^2
v = Velocity = ___________ in/sec
p = Screw pitch ___________ Threads/Inch
DS = Screw Diameter ___________ inches
W = Load ___________ LBS
F = Breakaway Force ___________ LBS
e = Efficiency of screw ___________ %
L=Length of Screw ___________ Inches
J = inertia ___________ oz-in^2
D1 = Dia Load pulley ___________ inches
D2 = Dia Motor Pulley ___________ inches
W1 = Weight Load pulley_____4____lb
W2 =Weight Motor Pulley_____9____lb



Formula | **Sizing Example**

Steps

Acceleration = a = -d = $\frac{2X}{t^2} = \frac{2(X/4)}{(S/3)^2} = \frac{4.5X}{S^2}$

(1) $a = -d = \frac{4.5X}{S^2} \quad \frac{4.5 * 30}{2.5^2} = 21.6$ in/sec^2

Velocity = at = $\frac{4.5X}{S^2} * \frac{S}{3} = \frac{1.5X}{S}$

(2) v= at= 1.5 (30 inch)/2.5Sec = 18 inch / Sec

Max $RPM_{motor} = \frac{\text{Max Speed * Lead Screw Pulley Dia * (60 sec)}}{\text{Pitch Dia * Motor Pulley Dia* (min)}}$

(3) $RPM_{motor} = \frac{\text{18 in/sec * 6 in * 60 sec}}{\text{1in/rev *4 in * min}} = 1620$ RPM

$Torque_{total} = (Torque_{Friction} + Torque_{Acceleration}$ oz - in) 1.10

(4) F = Force $_{Friction}$ = .25 * 500 lb * 16 oz/lb = 2000 oz

$Torque_{Friction} = \frac{F(D2/D1)}{2\pi * p * e}$ & F= $Force_{Friction} = u_s * W$

(5) $Torque_{Friction} = \frac{(4/6)\ 2000\ oz}{2\pi * 1.0\ threads/in * .65} = 326$ oz-in

$J_{Load\ @\ motor} = \frac{W(D2/D1)^2}{(2\pi p)^2}$

(6) $J_{Load\ @\ m} = \frac{500\ lb * 16\ oz/lb * (4/6)^2}{(2\pi * 1.0\ threads/in)^2} = 90.15$ oz-in^2

$J_{lead\ screw\ @\ motor} = \frac{\pi L?R^4 (D2/D1)^2}{2}$; ?= Steel density=4.48 oz/in^3

(7) $J_{lead\ screw\ @\ m} = \frac{\pi * 40in * 4.48oz/in^{3*} (1.75in/2)^4 (4/6)^2}{2}$

= 73.29 oz - in^2

$_{load\ pulley\ @\ motor} = \frac{W_{load\ Pulley} R^2_{load\ Pulley}}{2} * (D2/D1)^2$

(8) $J_{load\ p\ @\ motor} = \frac{9lb * 16\ oz/\ lb * 3^2 * (4/6)^2}{2} = 288$ oz-in^2

$_{Motor\ Pulley\ @\ motor} = \frac{W_{Motor\ Pulley} * R^2_{load\ Pulley}}{2}$

(9) $J_{Motor\ Pulley\ @\ motor} = \frac{6lb * 16\ oz/\ lb * 3^2}{2} = 432$ oz-in^2

$_{@\ motor} = 2\pi * p * velocity_{@\ t=.833\ sec} * (D1/D2)$= angular velocity

(10) $?_{@\ motor} = 2\pi * 1.0$ thread/in * 18 in/sec * (6/4)

= 169.56 radians/sec

$_{Motor\ @\ 1.5hp\ given\ in\ Marathon\ catalog}$ = 0.14 lb-ft^2

(11) J_{Motor} = 0.14 lb-ft^{2*} 16.0 oz/lb*(12in/1ft)^2 = 322.56 oz-in^2

$_{Accel} = \frac{?\ (J_{Load}/e + J_{lead\ screw} + J_{load\ pulley} + J_{Motor\ Pulley} + J_{Motor})}{gt}$

(12) $T_{Accel} = \frac{169.56\ (90.15\ /.65 + 73.29 + 288 + 432 + 322.56)}{386in/sec^2 * .833}$

= 661 oz-in

orque $_{total}$ = (Torque $_{Friction}$ + Torque $_{Acceleration}$ oz - in) 1.10

(13) Torque $_{total}$ = (326 oz-in + 661 oz-in) 1.10 = 1085 oz-in

IP = $\frac{Torque_{total} * (RPM\ max)}{5252*12in/\ lb*12in/ft}$

(14) HP = $\frac{1085\ oz\text{-}in * (1620\ RPM)}{5252*16\ oz/\ lb*12in/ft} = 1.75$ HP

Customer Data

Company Name	☐End user ☐Distributor ☐OEM
Contact Name #1 Contact Name #2	Contact Name #1 e-mail Contact Name #2 e-mail
Address	City
State	Zip
Phone	Fax

Machine Data

Type of application (Lead Screw, Conveyer, Rack and pinion, Turntable, Machine tool) ____________________

Material moved ____________________

p = Screw pitch ___________Threads/Inch

DS = Screw Diameter ___________ inches

W = Load ___________ LBS

F = Breakaway Force _____ ______ LBS

e = Efficiency of screw ___________ %

L=Length of Screw ___________ Inches

J = inertia ___________ $oz\text{-}in^2$

Transmission Data, Pulley or chain and sprocket

D1 = Diameter Load pulley or sprocket ___________ inches

D2 = Diameter Motor Pulley or sprocket ___________ inches

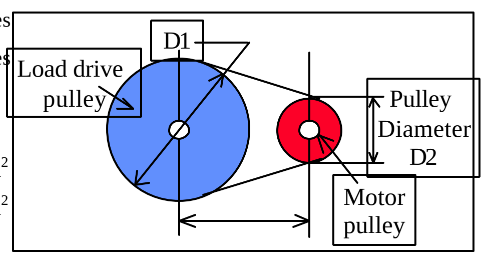
W1 = Weight Load pulley or sprocket ___________ lb

W2 =Weight Motor Pulley or sprocket ___________ lb

Inertia of Pulley or sprocket #1[A] ___________ $oz\text{-}in^2$

Inertia of Pulley or sprocket #2[A] ___________ $oz\text{-}in^2$

Efficiency ___________ %



[A] If not known, then review example above

Gear Box

Gear Box ratio ___________ Motor: Load

Inertia of Gear Box[B] ___________ oz-in^2

Efficiency ___________ %

Gears

D1 = Diameter Load Gear ___________ inches

D2 = Diameter Motor Gear ___________ inches

Number of teeth Load Gear ___________ teeth

Number of teeth Motor Gear ___________ teeth

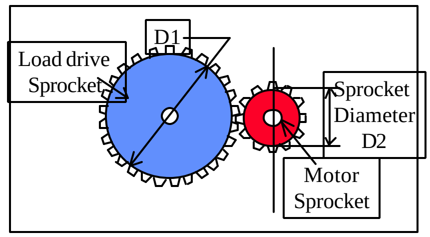
W1 = Weight Load pulley Gear ___________ lb

W2 =Weight Motor Gear ___________ lb

Inertia of Gear [A] ___________ oz-in^2

Inertia of Gear [A] ___________ oz-in^2

Efficiency ___________ %



Move Profile

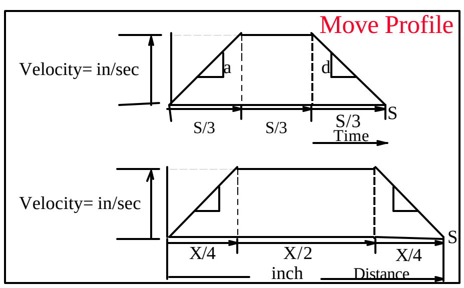
a = -d = Acceleration = ___________ in/sec^2 If Acceleration = Deceleration (90% of Applications)

Acceleration = ___________ in/sec^2 If Acceleration ≠ Deceleration

Deceleration = ___________ in/sec^2 If Acceleration ≠ Deceleration

Machine Design speed _____________ (Inches/ Seconds)

Minimum move profile _______________ seconds



[A] If not known, then review example above

Drive Data

Manufacture ______________________ Model # ________________________________

Horse Power ______________________

Winder Drive ☐ New Application ☐ Retrofit

Existing Voltage ☐ 230VAC ☐ 460VAC ☐ 575VAC

Existing Drive system ☐ AC drive ☐ DC drive

Existing Motor Data

Existing motor Manufacture __________________ Model # _________________________

New motor required ☐ Yes ☐ No

Existing motor full load ratings: __________________AMPS

__________________Volt

__________________RPM (850, 1150, 1750)

Conduit Box location (*if motor is to be replaced*) ☐ F1 ☐ F2 ☐ F3 or ☐ NA

Existing Blower Motor. __________Voltage, _______ Amps or ☐ NA

Existing Encoder Manufacture _______________________________ ☐ NA

Existing Encoder ☐ Digital ☐ Analog AC ☐ Absolute ☐ Analog DC

Existing Encoder Manufacturer. ________________________ ☐ NA

Resolution Existing Encoder (PPR) _______ OR Volts/RPM _________

Encoder Pickup ☐ Optical ☐ Magnetic pickup

Drive Enclosure information

Ambient Temperature in control room __________ °F or ___________ °C

Existing Drive Enclosure ☐ NEMA 1 ☐ NEMA 12 ☐ NEMA 4X ☐ AIR CONDITIONING

New Enclosure Spec ☐ NEMA 1 ☐ NEMA 12 ☐ NEMA 4X ☐ AIR CONDITIONING

Enclosure options ☐ Duplex outlet ☐ Lights ☐ Empty cabinet for future use

☐ Other ____

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Existing Power Distribution[4]

☐ Isolation Transformer _____ KVA Primary Voltage________ AC Secondary voltage ________ AC
☐ Line Reactors Impedence __________(%) ☐ Load Reactors Impedence ___________ (%)
☐ Dynamic Braking Resistor: Duty Cycle i.e. 3%, 5% __________% Resistance ___________Ohms
Dynamic Resistor Power rating ____________ Watts

Drive Communication Requirements

☐ Modbus Plus ☐ Modbus ☐ Device Net ☐ Profibus ☐ Arcnet LAN ☐ Other ________________

Drive Input Requirements

☐ Start ☐ Stop ☐ Forward ☐ Reverse ☐ Run
☐ Jog ☐ Preset Speed1 ☐ Preset Speed 2
☐ Other ____

Drive Output Requirements

☐ Drive alarm fault ☐ Drive severe fault ☐ Run ☐ Zero speed
☐ At speed ☐ Encoder feedback pass through (PGX card)
☐ Other ____

Comment [mkm1]: May need Analog output to replace the individual pump pressure sensors.

Analog Input

☐ speed reference ☐ 0-10VDC ☐ 4-20ma ☐ Other __________________________________

Analog Output

☐ Drive Speed (Ft/minute) ☐ Bus Voltage ☐ Other ______________________________

Special Types of Control

☐ Drive system start ☐ Drive system stop ☐ Regenerative to fast stop - full current limit or ramped
☐ DC Bus Over Voltage Suppression (Used to prevent overvoltage tripping from an unbalanced load)
☐ Other ____

[4] The existing power distribution is required if Yaskawa is providing a drive system